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SS Lande
Associate Professor,
Department of Entomology,
SSAC, Amravati, Maharashtra,
India

YR Sable
Assistant Professor,
Department of Entomology,
SSAC, Amravati, Maharashtra,
India

KP Budhvat
Assistant Professor,
Department of Entomology,
SSAC, Amravati, Maharashtra,
India

PB Salunke
Ph.D., Student, Department of
Entomology, Dr. PDKV, Akola,
Maharashtra, India

SR Pawar
Assistant Professor,
Department of Entomology
RMAC, Navha, Maharashtra,
India

Correspondence
SS Lande
Associate Professor,
Department of Entomology,
SSAC, Amravati, Maharashtra,
India

Module based management of *Helicoverpa armigera* on pigeonpea

SS Lande, YR Sable, KP Budhvat, PB Salunke and SR Pawar

Abstract
The present investigation were conducted at Dr. PDKV, Akola for module based management of *Helicoverpa armigera* of pigeon pea. The four modules *viz.*, Chemical module-I, (first spray of azadirachtin 10,000 ppm, at 50 percent flowering, second spray of emamectin benzoate 5%SG, 15 days after 1st spray, third spray of deltamethrin 1% + trizophos 35%, 15 days after 2nd spray). Chemical module-II, (first spray of profenophos 50 EC at bud initiation stage, second spray of flubendiamide 20 WDG at 50 percent flowering, third spray of indoxacarb 15.8 EC at 15 days after 50 percent flowering). Bio-control module, (first spray of azadirachtin 10000 ppm at bud initiation stage, second spray of HaNPV @ 500 LE/HA + Silver nano particle at 50 percent flowering, third spray of spinosad 45 SC @ at 15 days after 50 percent flowering) and IPM module (Ploughing in summer, Removal and destruction of stubbles, Removal of alternate hosts, Seed treatment with *Trichoderma*, Mechanical collection of larvae and spraying of recommended insecticides at ETL if needed) and an untreated control were tested.
The observations on the effect of modules on larval population of *H. armigera* were found statistically significant. However, the Chemical module-II (M2) recorded minimum population of *H. armigera* i.e. 0.28 larvae per plant and emerged as most effective module and was found significantly superior over all other modules. It was followed by the Chemical module-I (recording 0.44 larvae of *H. armigera* per plant), which recorded statistically significant differences over the IPM module (M4) and Bio-control module (M3).
However, IPM module (M4) and Bio-control module (M3) recorded 0.58 and 0.61 *H .armigera* larvae per plant and were significantly superior over an untreated control, but module M1, M2 and M3 showed statistical similarity with each other. While, an untreated control (M5) recorded highest population i.e. 1.13 larvae per plant.

Keywords: *Helicoverpa armigera*, pigeonpea, spinosad, flubendamide

1. Introduction
Pigeonpea, *Cajanus cajan* (L) Mill. vernacularly known as Red gram, *Arhar* or *Tur* is one of the most important pulse crop. Among the biotic and abiotic factors responsible for low yields of pigeonpea, insect pests are the major ones. More than 250 insect pests are reported on pigeonpea and extent of damage caused by insect pests varies from 30 to 80 percent (Sharma *et al.*, 2010) [12]. Out of these *Helicoverpa armigera* (Hubner) and pod fly (*Melanagromyza obtusa* Malloch) are important constraints in attainment of desired production and productivity of pigeonpea (Sharma *et al.*, 2008) [10].
Various methods have been tried for the control of pod borer complex, but agrochemicals are still the first choice of farmers. Management of pod borer complex in pigeonpea relies heavily on insecticides, often to the exclusion of other methods of control, because of their quick action, effectiveness and adaptability to various situations. Considerable numbers of insecticides have been tested and few of them found effective against the pod borers in pigeonpea (Yadav and Dahiya, 2004) [18]. Sole reliance on chemical pesticides led to development of resistance and resurgence of secondary pests. With reports of pesticide resistance in pod borer (Kranthi *et al.*, 2002) [9] and subsequent promotion of IPM, highlighted the need for development of safe, economic and effective pest management strategies. The use of alternatives, based on botanical pesticides (eg. neem) and insect pathogens, particularly the *Helicoverpa armigera* nuclear polyhedrosis virus (*Ha*NPV), gained popularity as safe for applicators, beneficial insect fauna, targeting pod borer and pod fly and the environment (Sharma *et al.*, 2011) [12].

2. Material and Methods
The investigations were carried out with a view to evaluate the effective module for the management of pod borer complex of pigeonpea.

The experiments were carried on the field as well as in the laboratory of the Department of Entomology, Dr. P.D.K.V., Akola continuously for two years i.e. 2012-13 and 2013-14. The material required and methods followed for conducting the experiments are described below.

2.1 Material and Methods
A field trial was conducted using CRBD Completely Randomised Block Design in Kharif season with five treatments (Modules 1-5) replicated four times for Management of Helicoverpa armigera in pigeonpea crop variety ICPL87119 (Asha) with spacing of 90X30 Cm in the gross plot size of 7.2 X 3.6 m^2 (Net Size 5.4x 3.0 m^2)

Treatment details are as under

M1 - Chemical module I (University Recommended)
- First spray of azadirachtin 10,000 ppm, 10 ml/10 lit of water at 50 percent flowering.
- Second spray of emamectin benzoate 5% SG, 3 g/10 lit of water, 15 days after 1st spray.
- Third spray of deltamethrin 1% + triazophos 35%EC, 25ml/10 lit of water, 15 days after 2nd spray.

M2 - Chemical module II
- First spray of profenophos 50 EC @ 25ml/10 lit of water at bud initiation stage
- Second spray of flubendamide 20 WDG @ 5 g/10 lit of water at 50 percent flowering.
- Third spray of indoxacarb 15.8 EC @ 5 ml/10 lit of water at 15 days after 50 percent flowering.

M3 - Bio-control module
- Azadirachtin 10000 ppm @ 10 ml/10 lit of water at bud initiation stage.
- *Ha*NPV @ 500 LE/ha + Silver nano particle 0.80 micro liter/ml *Ha*NPV at 50 percent flowering.
- Spinosad 45 SC @ 3ml /10 lit of water at 15 days after 50 percent flowering.

M4 - IPM module
- Ploughing in summer
- Removal and destruction of stubbles
- Removal of alternate hosts
- Seed treatment with *Trichoderma*
- Mechanical collection of larvae
- Spraying of recommended insecticides at ETL if needed

M5 - Untreated Control
The spray material of desired concentration of emamectin benzoate, indoxacarb, spinosad, flubendiamide, azadirachtin, deltamethrin 1% + triazophos 35%, profenophos and *Ha*NPV was freshly prepared in the field separately just before the start of spraying operation. The quantity of spray material required for coverage of crop was prepared by adopting the following formula: V = C x A / % a.i.

2.2 Spraying procedure

The details of spraying undertaken are as below.

Time of Application	Dates of spraying	
	2012-13	2013-14
M1- 1st spray at 50 percent flowering, 2nd spray 15 days after 1st spray. 3rd spray 15 days after 2nd spray.	1/11/2012 16/11/2012 1/12/2012	12/11/2013 27/11/2013 12/11/2013
M2- 1st spray at bud initiation stage, 2nd spray at 50 percent flowering 3rd spray 15 days after 2nd spray.	19/10/2012 1/11/2012 16/11/2012	21/10/2013 12/11/2013 27/11/2013
M3 1st spray at bud initiation stage, 2nd spray at 50 percent flowering 3rd spray 15 days after 2nd spray	19/10/2012 1/11/2012 16/11/2012	21/10/2013 12/11/2013 27/11/2013
M4 IPM + need based sprays	16/11/2012	27/11/2013
M5 Untreated Control	No sprays	No sprays

2.3 Methods of recording observations
The observations were recorded on three, 10 cm twigs of five randomly selected plants per net plot and labelled. The first pretreatment observations were recorded 24 hours before treatment followed by weekly observations. The observations were recorded on the following aspects, Larval population of *H. armigera,* Pod damage on green pods separately. Pod damage, Grain damage and yield at harvest separately.

2.4 Larval population of *H. armigera* and *E. atomosa*
Five plants from each net plot and three twigs/plant i. e. one each from top, middle and bottom were selected and tagged for observation. The total number of *H. armigera* and *E. atomosa* larvae were recorded on these twigs.
Pretreatment observations were recorded 24 hours before application of treatments and the post treatment observations were noted at an interval of 7 days (weekly) after pre treatment observation. From these the population of *H. armigera* and *E. atomosa* was calculated separately.

2.5 Economics of Different Treatments
The data on grain yield were used to calculate the economic viability of each treatment. The costs of each treatment and labours required for application were calculated as per market rate. Similarly, the income obtained from the sale of grains as per prevailing rates was also calculated for each treatment. The data thus obtained were used to calculate the monitory returns and incremental cost benefit ratio (ICBR) of various treatments.
The data collected from each year of experimentation were averaged out for respective parameter and subjected for analysis of variance. Similarly, the result of both the years were pooled and averages were worked out. The data thus obtained were transformed appropriately to arc sine and square root transformation wherever necessary as per Gomez and Gomez (1984) and further statistical analysis was done for testing of the level of significance.

3. Results and Discussion

The data thus obtained were subjected to statistical analysis after appropriate transformations and are presented in Table 1 and 2. Pooled data of two years are presented in Table No.3

Table 1: Effect of Different Modules on Larval Population of *H. armigera* - 2012-13

Tr. No. (Module)	Treatments	*H. armigera* larvae/plant								Mean (Module effect)
		7 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	49 DAT	56 DAT*	
M1	Chemical Module-I	1.10	0.30	0.25	0.30	0.25	0.30	0.50	0.35	0.42
		(1.05)	(0.54)	(0.49)	(0.54)	(0.49)	(0.54)	(0.70)	(0.59)	(0.62)
M2	Chemical Module-II	0.50	0.25	0.20	0.25	0.20	0.25	0.30	0.35	0.29
		(0.70)	(0.49)	(0.45)	(0.49)	(0.45)	(0.49)	(0.54)	(0.59)	(0.52)
M3	Bio-Control Module	0.70	0.30	0.40	0.45	0.30	0.70	0.55	1.20	0.57
		(0.83)	(0.54)	(0.63)	(0.67)	(0.54)	(0.83)	(0.74)	(1.09)	(0.73)
M4	IPM Module	0.90	0.40	0.25	0.45	0.55	0.35	1.10	0.80	0.60
		(0.94)	(0.63)	(0.49)	(0.67)	(0.74)	(0.59)	(1.05)	(0.89)	(0.75)
M5	Untreated Control	1.20	0.50	0.50	0.55	0.80	1.10	1.30	1.60	0.94
		(1.09)	(0.70)	(0.70)	(0.74)	(0.88)	(1.05)	(1.13)	(1.26)	(0.94)
F-test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)		0.07	0.04	0.03	0.04	0.04	0.04	0.07	0.05	0.04
CD at 5%		0.21	0.12	0.11	0.12	0.13	0.14	0.21	0.16	0.12
CV%		14.75	13.58	12.50	13.01	13.57	12.58	16.24	11.59	10.22

Figures in parentheses are corresponding square root values * DAT- Days after first treatment

Table 2: Effect of Different Modules on Larval Population of *H. armigera* – 2013-14

Tr. No. (Module)	Treatments	*H. armigera* larvae/plant								Mean (Module effect)
		7 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	49 DAT	56 DAT*	
M1	Chemical Module-I	0.40	0.40	0.50	0.85	0.40	0.35	0.25	0.50	0.46
		(0.63)	(0.63)	(0.70)	(0.91)	(0.62)	(0.58)	(0.49)	(0.70)	(0.66)
M2	Chemical Module-II	0.30	0.30	0.20	0.35	0.25	0.20	0.20	0.40	0.27
		(0.54)	(0.54)	(0.45)	(0.56)	(0.49)	(0.45)	(0.45)	(0.63)	(0.51)
M3	Bio-Control Module	0.50	0.60	0.90	1.20	0.45	0.40	0.65	0.75	0.68
		(0.70)	(0.77)	(0.94)	(1.09)	(0.67)	(0.62)	(0.80)	(0.86)	(0.81)
M4	IPM Module	0.40	0.45	0.80	1.00	0.35	0.40	0.60	0.60	0.57
		(0.63)	(0.67)	(0.89)	(0.99)	(0.58)	(0.62)	(0.77)	(0.77)	(0.74)
M5	Untreated Control	0.55	0.65	1.20	1.40	1.30	1.60	1.40	2.20	1.29
		(0.73)	(0.80)	(1.09)	(1.18)	(1.14)	(1.26)	(1.18)	(1.48)	(1.11)
F-test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)		0.04	0.04	0.05	0.07	0.06	0.04	0.05	0.05	0.04
CD at 5%		0.12	0.13	0.15	0.22	0.19	0.13	0.14	0.16	0.12
CV%		12.19	12.00	11.98	15.29	17.95	12.39	12.30	11.34	10.15

Figures in parentheses are corresponding square root values * DAT- Days after first treatment

Effect of Different Modules on Larval Population of *H. armigera* (Pooled)

The pooled mean data of 2012-13 and 2013-14 presented in Table 3 revealed that all the modules tested against *H. armigera* were found significantly superior over an untreated control. However, the Chemical module-II (M2) recorded minimum population of *H. armigera* i.e. 0.28 larvae per plant and emerged as most effective and was found significantly superior over all other modules. This was followed by the Chemical module-I (M1) recording 0.44 larvae of *H. armigera* per plant, which recorded statistically significant differences over the IPM module (M4) and Bio-control module (M3).

The IPM module (M4) and Bio-control module (M3) recorded 0.58 and 0.61 *H .armigera* larvae and were significantly superior over an untreated control, but Module M1, M2 and M3 showed statistical similarity with each other. However, an untreated control (M5) recorded highest population i.e. 1.13 larvae per plant.

The effectiveness of Chemical module-II (first spray of profenophos 50 EC at bud initiation stage, second spray of flubendiamide 20 WDG at 50 percent flowering, third spray of indoxacarb 15.8 EC at 15 days after 50 percent flowering) against *H. armigera*, has been widely demonstrated by several workers like Giraddi *et al.*, (2002) [7], Chandrakar *et al.*, (2006) [3], Singh and Yadav (2006b) [19], Thilagam and Kennedy (2006) [16], Srinivasan and Durairaj (2007) [14], Jayashri Ughade *et al.*, (2008) [8], Babariya *et al.*, (2010) [2], Deshmukh *et al.*, (2010) [5], Mahendra *et al.*, (2011), Dey *et al.*, (2012) [4] Priyadarshini *et al.*, (2013) [10], Wadaskar *et al.*, (2013) [17] and Sreekanth *et al.*, (2014) on pigeonpea crop. They have also found that these insecticides proved better for management of *H. armigera* on pigeonpea, while, Profenophos, Flubendiamide and Indoxacarb insecticides were reported as most effective. Profenophos a non-systemic insecticide and acaricide with contact and stomach action, exhibits a translaminar effect and has ovicidal properties. Flubendiamide results in permanent insect body contraction, leading to rapid cessation of feeding and thus suppression of feeding damage. Indoxacarb causes cessation of feeding upon direct contact or ingestion of treated areas which would result in mild convulsions and passive paralysis, from which they would never recover.

Moreover, the insecticide molecule was reported as most effective against *H. armigera* by Singh and Yadav (2006b) [19] stating that, indoxacarb gave best results against pod borer *H. armigera* in pigeonpea in reducing crop damage.

The effectiveness of Indoxacarb has been widely demonstrated by several workers like Jayashri Ughade *et al.*, (2008) [8]. Babariya *et al.*, (2010) [2] reported that the treatment of indoxacarb 0.0075% caused highest mortality (89 to 96%) of the pest whereas, Mahendra *et al.*, (2011) reported the efficacy of indoxacarb (0.007%) against *H. armigera*.

The efficacy of flubendiamide and indoxacarb insecticides against *H. armigera* (Hubner) infesting chickpea resulted as most effective in reducing the *H. armigera* population (Deshmukh *et al.*, 2010) [5] and also on pigeonpea (Wadaskar *et al.*, 2013) [17] which confirms the present findings.

Table 3: Effect of Different modules on Larval Population of *H. armigera* (Pooled)

Tr. No. (Module)	Treatments	*H. armigera* Larvae/plant		
		2012-13	2013-14	Pooled
M1	MODULE :1 Chemical module I First spray of Azadirachtin 10,000 ppm, 10 ml/10 lit of water at 50 percent flowering. Second spray of Emamectin benzoate 5% SG, 3 g/10 lit of water, 15 days after 1st spray. Third spray of deltamethrin 1% + Triazophos 35%, 25 ml/10 lit of water, 15 days after 2nd spray.	0.42 (0.62)	0.46 (0.66)	0.44 (0.66)
M2	MODULE :2 Chemical module II First spray of profenophos 50 EC @ 25 ml/10 lit of water at bud initiation stage Second spray of Flubendiamide 20 WDG @ 5g/10 lit of water at 50 percent flowering. Third spray of Indoxacarb 15.8EC @ 5 ml/10 lit of water at 15 days after 50 percent flowering.	0.29 (0.52)	0.27 (0.51)	0.28 (0.52)
M3	MODULE :3 Bio-control module Azadirachtin 10000 ppm @ 10 ml/10 lit of water at bud initiation stage. *Ha*NPV @ 500 LE/HA + Silver nano particle 0.80 micro liter/ml *Ha*NPV @ 500 LE/ha at 50 percent flowering. Spinosad 45 SC @ 3ml /10 lit of water at 15 days after 50 percent flowering.	0.57 (0.73)	0.68 (0.81)	0.63 (0.77)
M4	MODULE :4 IPM module Ploughing in summer Removal and destruction of stubbles Removal of alternate hosts Seed treatment with *Trichoderma* Mechanical collection of larvae Spraying of recommended insecticides at ETL if needed	0.60 (0.75)	0.57 (0.74)	0.59 (0.75)
M5	MODULE :5 Untreated Control	0.94 (0.94)	1.29 (1.11)	1.12 (1.03)
F- test		Sig.	Sig.	Sig.
SE (m)		0.04	0.04	0.03
CD at 5%		0.12	0.12	0.12
CV %		10.22	10.15	10.93

Figures in parentheses are corresponding square root values

Pooled Effect of Different Modules on Grain Yield of Pigeonpea

The pooled yield data presented in Table 4. was found statistically significant. The maximum yield was recorded in the Chemical module-II (M2) (2103 Kg/ha). The next effective modules were the Chemical module-I (M1) and the Bio-control module (M3), which recorded 1968 and 1780 Kg/ ha yields, respectively and were found statistically similar. The IPM module (M4) and an untreated control, recorded lower yields of 1680 and 1543 Kg/ha, respectively and both the modules were at par with each other.

Table 4: Effect of Different Modules on Grain Yield of Pigeonpea (Pooled)

Treatments		Yields Kg/ha.		
		2012-13	2013-14	Pooled
		Kg/ha	Kg/ha	Kg/ha
M1	Chemical Module I	1890	2045	1968
M2	Chemical Module II	2006	2199	2103
M3	Bio-control Module	1825	1736	1780
M4	IPM Module	1601	1760	1680
M5	Untreated Control	1466	1620	1543
F-test		Sig.	Sig.	Sig.
SE(m)		88.90	112.13	74.54
CD at 5%		273.90	373.18	216.25
CV%		10.12	12.94	11.62

Pooled Effect of Different Modules on Grain Yield of Pigeonpea

The pooled yield data presented in Table 4 was found statistically significant. The maximum yield was recorded in the Chemical module-II (M2) (2103 Kg/ha). The next effective modules were the Chemical module-I (M1) and the Bio-control module (M3), which recorded 1968 and 1780 Kg/ ha yields, respectively and were found statistically similar. The IPM module (M4) and an untreated control, recorded lower yields of 1680 and 1543 Kg/ha, respectively and both the modules were at par with each other.

The efficacy of Chemical module-II, with first spray of profenophos 50 EC at bud initiation stage, second spray of flubendiamide 20 WDG at 50 percent flowering, third spray of indoxacarb 15.8 EC at 15 days after 50 percent flowering in terms of grain yield realisation, has been demonstrated by Giraddi *et al.*, (2002) [7], Singh and Yadav, (2005), Chandrakar *et al.*, (2006) [3], Singh and Yadav (2006b) [19], Srinivasan and Durairaj (2007) [14], Dodia *et al.*, (2009) [6], Deshmukh *et al.*, (2010) [5], Dey *et al.*, (2012) [4], Tavaragondi *et al.*, (2013) [15], Wadaskar *et al.*, (2013) [17] and Ajagol *et al.*, (2014) [1].

Moreover, the insecticide molecule - Profenophos, Flubendiamide and Indoxacarb were reported as most effective for recurring grain yield by Giraddi *et al.*, (2002) [7] stating that Indoxacarb 15.8 EC was found more effective against *H. armigera* recording average seed yield of 1.40 t/ha.

Based on residual toxicity, Profenophos was most effective in larval control. Application of Profenophos produced significantly higher grain yield (1516 kg/ha) (Chandrakar *et al.*, 2006) [3]. Singh and Yadav (2006b) [19] revealed that, indoxacarb gave best results in reducing crop damage. The study also indicated that maximum grain yield was received from indoxacarb treatment.

Deshmukh *et al.*, (2010) [5] reported flubendiamide 0.007 percent, indoxacarb 0.0075 percent, as the effective insecticide in reducing the *H. armigera* population translating into higher yield in the treatment of flubendiamide 0.007 percent (1850 kg/ha) and was followed by indoxacarb 0.0075 percent (1805 kg/ha). Dey *et al.*, (2012) [4] stated that the highest seed yield was recorded in the treatment of flubendiamide 480 SC.

Wadaskar *et al.*, (2013) [17] revealed superiority of flubendiamide 20 WDG treatment which resulted into highest yield, which supports the present findings.

Incremental Cost Benefit Ratio (ICBR) of Different Treatments

The values of different treatments are presented in Table 5. The data indicated that the Chemical module-II (M2) was most economically viable treatment, since this treatment recorded highest ICBR of 1:4.00. It was followed by the Chemical module-I (M1) which recorded the ICBR of 1:3.59. However, the modules such as the Bio-control module (M3) and the IPM module (M4) were also found economically better recording the higher ICBR of 1:3.46 and 1:0.96, respectively.

The efficacy of Chemical module-II, which includes first spray of profenophos 50 EC at bud initiation stage, second spray of flubendiamide 20 WDG at 50 percent flowering, third spray of indoxacarb 15.8 EC at 15 days after 50 percent flowering in terms of ICBR, has been demonstrated by several worker such as Singh and Yadav (2006[b]) [19], Dodia *et al.*, (2009) [6], Deshmukh *et al.*, (2010) [5], Priyadarshini *et al.*, (2013) [10], Tavaragondi *et al.*, (2013) [15] and Wadaskar *et al.*, (2013) [17]. However, the insecticide molecule -Profenophos, Flubendiamide and Indoxacarb were reported as most effective in recording higher ICBR by Singh and Yadav (2006[b]) [19], revealing that, indoxacarb gave best results in reducing crop damage and also indicated that maximum profit was received from indoxacarb treatment which gave benefit of Rs. 18.82 against one rupee investment.

Dodia *et al.,* (2009) [6] stated that the maximum monitory return was gained in the treatment of indoxacarb (ICBR=1:6.88) followed by flubendiamide (ICBR=1:4.56). This was supported by Priyadarshini *et al.*, (2013) [10] stating that the highest net profit was obtained from the treatment flubendiamide 480 SC (Rs. 12,638) per hectare.

Wadaskar *et al.*, (2013) [17] revealed the superiority of flubendiamide 20 WDG against higher monetary returns (14,657 Rs/ha) and highest Incremental Cost Benefit Ratio (ICBR 1:6.8) rendering flubendiamide as a cost effective alternative for pod borer management in pigeonpea followed by indoxacarb 14.5 SC, stating that these insecticides may also be recommended as potent alternatives in management of pod borer complex of pigeonpea, which confirmed the present findings.

Table 5: Effect of Different Modules on ICBR.

Sr. No.	Treat ments	Cost of module (Rs/ha)	Labour cost for each application (Rs/ha)	Labour cost for module (Rs/ha)	Sprayer cost	Total cost (Rs/ha) 'A'	Yield (q/ha)	Yield increased over control (q/ha)	Value of Increased Yield (in Rs.) 'B'	Incremental benefit B-A (in Rs.)	ICBR	Rank
1	M1	1965	600	1800	300	4065	19.68	4.24	18672.72	14607.72	3.59	2
2	M2	2825	600	1800	300	4925	21.03	5.59	24614.04	19689.04	4.00	1
3	M3	3221	600	1800	300	5321	17.80	2.37	10419.2	5098.2	0.96	4
4	M4	650	600	600	100	1350	16.80	1.37	6019.2	4669.2	3.46	3
5	M5						15.43	0.00				5

Conclusion

Effect of Different Modules on Larval Population of *H. armigera*

The observations on the effect of modules on larval population of *H. armigera* were found statistically significant. However, the Chemical module-II (M2) recorded minimum population of *H. armigera* i.e. 0.28 larvae per plant and emerged as most effective module and was found significantly superior over all other modules. It was followed by the Chemical module-I (recording 0.44 larvae of *H. armigera* per plant), which recorded statistically significant differences over the IPM module (M4) and Bio-control module (M3).

However, IPM module (M4) and Bio-control module (M3) recorded 0.58 and 0.61 *H .armigera* larvae per plant and were significantly superior over an untreated control, but module M1, M2 and M3 showed statistical similarity with each other. While, an untreated control (M5) recorded highest population i.e. 1.13 larvae per plant.

Effect of Different Modules on Grain Yield of Pigeonpea

The highest grain yield of 2103 kg/ha was obtained in the Chemical module-II (M2). The Chemical module-I (M1) and the Bio-control module (M3) registered yield levels of 1968 and 1780 Kg/ ha, respectively. The IPM module (M4) recorded lower yield of 1680 kg/ha as against 1543 Kg/ha in an untreated control. The highest ICBR of 1:4.00 was estimated in the Chemical module-II (M2) and was economically most viable module. It was followed by the Chemical module-I (M1) which recorded ICBR of 1:3.59, whereas, the Bio-control module (M3) and the IPM module (M4) recorded comparatively lower ICBR of 1:3.46 and 1:0.96, respectively.

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